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Detector Stability of the Terra MODIS Thermal Emissive Bands

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ABSTRACT

The MODerate Resolution Imaging Spectroradiometer (MODIS) is one of the key instruments for the NASA s Earth Observing System (EOS). The MODIS ProtoFlight Model (PFM) was launched on-board the EOS Terra spacecraft on December 18, 1999. The science data acquisition started on February 24, 2000. Since then it has been providing the science community and public users unprecedented amount of data sets for the global monitoring of the Earth s land, oceans, and atmosphere. MODIS has 36 spectral bands with wavelengths ranging from 0.41 micrometer to 14.5 micrometers. Its 16 thermal emissive bands (TEB) range from 3.7 to 14.2 micrometers and have a total of 160 individual detectors (10 detectors per band). The thermal emissive bands are calibrated on-orbit by an on-board calibrator blackbody (OBC BB) on a scan by scan basis. The detectors responses to the BB source track their operational stability and therefore their noise characteristics as well. In this paper, we provide a brief review of the MODIS TEB on-orbit calibration algorithm with a focus on detector stability using over three years of on-orbit calibration data sets. The on-orbit changes in detectors responses from one operational configuration to another, the changes within the same operational condition, and the impact of these changes on the calibration and on the Earth scene observations are carefully examined. Except for a few detectors that were identified from pre-launch or became noisy on-orbit, the overall performance of MODIS TEB detectors is very satisfactory according to the design specifications.

Keywords: Terra, MODIS, detectors, stability, calibration, thermal emissive bands, blackbody

1. INTRODUCTION

The MODerate Resolution Imaging Spectroradiometer (MODIS) ProtoFlight Model (PFM) was launched on-board the NASA s Earth Observing System (EOS) Terra spacecraft on December 18, 1999. The MODIS instrument nadir aperture door opened on February 24, 2000 to start the science data acquisition. This marked a new era for comprehensive monitoring of the Earth s land, oceans, and atmosphere via instrument observations in the spectral regions from visible (VIS) to long-wave infrared (LWIR). Since then it has been providing the science community and public users calibrated data sets that serve as input for about 40 science products, including aerosol concentration and optical properties, atmospheric profiles, snow and sea-ice cover, land surface and sea surface temperature, and ocean bio-properties[1-5].

The quality of the science products depends on the instrument s calibration and characterization and on its actual on-orbit performance. MODIS has 36 spectral bands: 20 reflective solar bands (bands 1-19, and 26) and 16 thermal emissive bands (bands 20-25, and 27-36), making continuous observations at three spatial resolutions (nadir): 250m (bands1-2), 500m (bands 3-7), and 1000m (bands 8-36) with a wide field of view (FOV). The 16 thermal emissive bands (TEB), with wavelengths from 3.7 to 14.2 micrometers, have a total of 160 individual detectors (10 detectors per band). Each detector is treated as an individual radiometer and calibrated on-orbit by an on-board calibrator blackbody (OBC BB) on a scan-by-scan basis[6-7]. In this paper we provide a brief review of the MODIS TEB on-orbit calibration algorithm and evaluate the Terra MODIS TEB on-orbit performance by analyzing the detectors response stability and corresponding noise characterization. We use the detectors responses to the blackbody source at a fixed temperature setting (i.e., fixed sensor input radiance from the BB) to track the detectors stability and their noise characterization. Examples are presented using data sets collected from MODIS over 3.5 years of on-orbit calibration and characterization. The on-orbit changes in detectors responses from one operational configuration to another, the stability within the same operational condition, and their impact on the calibration and on the Earth scene observations are also discussed. Results show that the overall performance of MODIS TEB detectors is satisfactory with respect to the instrument design specifications.

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